STABRO LABORATORIES

INSTRUCTIONS

for the

WESTON® MODEL 639 Type 2

AC INDUSTRIAL ANALYZER

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614 FRELINGHUYSEN AVENUE, NEWARK, N.J. 07114

WESTON
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MP MASTER
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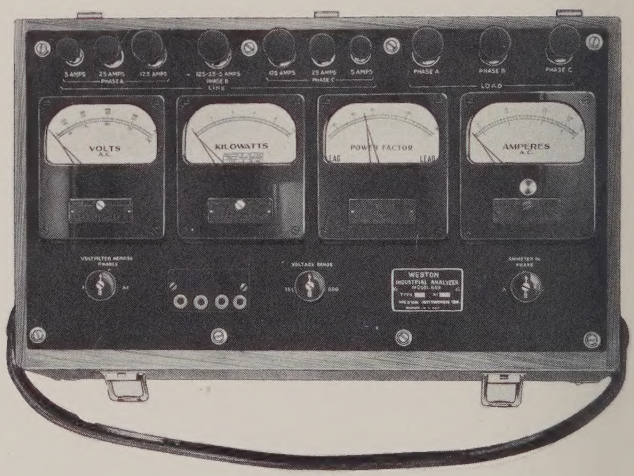


WESTON MODEL 639, TYPE 2
AC INDUSTRIAL ANALYZER

SPECIFICATIONS

Ranges:

- Voltage . . . . . 600/300/150 Volts
- Current . . . . . 125/25/5 Amperes
- Watts . . . . . 100/50/25/20/10/5/4/2/1 Kilowatts
- Power Factor . . . . . 0.30 Lag through unity to 0.80 Lead

Usage . . . . . For use on 3 phase, 3 wire circuits

Weight . . . . . 32 pounds (approx.)

Dimensions . . . . . 18 7/8 in. x 10 7/8 in. x 6 7/8 in.

WESTON MODEL 639, TYPE 2
INDUSTRIAL ANALYZER

General Description

The analyzer is designed for alternating current circuits and should not be used on direct current.

It consists of a voltmeter, ammeter, wattmeter and power factor meter, together with two current transformers and the necessary switches suitably connected to facilitate the industrial testing of three phase, three wire loads.

While this analyzer has been designed primarily for three phase, three wire loads it can be used for measurements on single phase and other polyphase circuits.

So long as the currents and voltages to be measured are within the ranges of the analyzer, including the overload limits, it may be left in circuit continuously.

Before connecting, it is advisable to set the voltage range changing switch to the 600 volt range unless the voltage to be measured is definitely known to be suitable for a lower range.

A phase rotation of A-B-C is assumed and connections must be made to produce this at the analyzer so that correct indications may be obtained from the power factor meter when testing on a three phase, three wire load.

If the power factor meter indicates "Lead" instead of "Lag" the phase rotation at the analyzer is C-B-A. It is then necessary to interchange the wires connected to the "Line" binding post "A" and "C". If it is necessary to keep the same phase rotation at the load, connections to the "Load" binding posts "A" and "C" should also be reversed.

When testing other than a balanced 3 phase 3 wire load the indications of the power factor meter should be disregarded.

The following detailed description should enable the user to understand the important facts concerning the analyzer and its uses.

Voltmeter

The voltmeter is of the movable iron type having its series resistance divided with a part connected to each side of the line under test.

Its indications are correct to ± 1% of the full scale value on any range, at any temperature between 10° and 40° C., on any frequency from 25 to 125 cycles per second and on ordinary commercial wave forms.

Wattmeter

The wattmeter is of the electrodynamometer type, having two elements, designed for polyphase or single phase measurements.

The indications of the wattmeter, together with the transformers contained in the analyzer, are correct to ± 2% of the full scale value on any range, at any temperature between 0° and 50° C., on any frequency from 25 to 125 cycles per second and on ordinary commercial wave forms.

The electrical circuits are insulated from each other and the elements are shielded from magnetic or electrostatic effects upon each other.

Multiplying factors for the scale reading, depending on the current and potential ranges used, are to be found on the wattmeter scale.

Power Factor Meter

The power factor meter is of the crossed coil electrodynamometer type designed for balanced three phase three wire loads.

Its indications are correct to ± .01 PF when connected to a three phase three wire balanced load so that the phase rotation is A-B-C, at any temperature between 0° and 50°C, at any frequency from 25-125 cycles per second, and on ordinary commercial wave forms. This same accuracy is maintained when the current is within 20 to 125% of the normal rating, i.e., 1 to 6.25 amperes on the low range, 5 to 31 amperes on the medium range and 25 to 156 amperes on the high range.

When the analyzer is connected to single phase, two phase, or three phase four wire loads the indications of the power factor meter should be disregarded.

Ammeter

The ammeter is of the movable iron type designed for use with the current transformers contained in the analyzer.

The indications of the ammeter, together with the transformer contained in the analyzer, are correct within ± 1% of the full scale value at any temperature between 10° and 40° C., at any frequency from 25 to 125 cycles per second and on ordinary commercial wave forms.

Independent of the transformers, the ammeter has a full scale range of 1 ampere. The scale is expanded in the center and contracted at the upper end. This characteristic is useful for motor testing.

In order to measure the starting current of a motor, or other device which requires more current at start than during its normal operation, an adjustable backstop is provided to deflect the movable system to a position just below the anticipated maximum starting current.

By deflecting the movable system to this point, with the adjustable backstop, the time required for the movable system to deflect to this position is saved, thereby obtaining a reading as near correct as possible with this form of indicating instrument.

The standard analyzer is guaranteed on the basis of a sinusoidal current and voltage, at frequencies as indicated below, and at 25° Centigrade. Commercial deviations from sinusoidal wave form will rarely cause additional errors; temperature variations encountered in practice will rarely increase the errors beyond the figures below.

Inst.	Range	Accuracy % of Full Scale		
		25-125 Cycles	200 Cycles	400 Cycles
Am.	All	±1	±1	+0.5 to —1.5
Watt.	All	±2	+1 to —3	0 to —4
P. F.	All	±.01 P. F.	±.02 P. F.	±.03 P. F.
Vm.	600	±1	±1	0 to —2
Vm.	300	±1	0 to —2	—2.5 to —4.5
Vm.	150	±1	—2.5 to —4.5	—13.5 to —15.5

The analyzer can be furnished compensated for use at higher frequencies as follows:

1. Compensated for 25-200 cycles.
2. 150 Volt range compensated for 25-400 cycles.
3. 300 Volt range compensated for 25-400 cycles.
4. All instruments and ranges compensated for 400 cycles
5. All instruments and ranges except low range of voltmeter compensated for 400 cycles.

Switching

All switches may be operated while analyzer is in use at any voltage or current within the range of the analyzer.

The ammeter switch is so designed that the transformer secondary circuits are never opened.

Overload Capacity

The potential circuits are not designed to be used beyond their rating.

The current circuits are designed to be used continuously at 25% above their rated values and may be subjected to even greater overloads for periods of time as shown in following table:

	Current, Amperes		
Seconds	5 Amp. Range	25 Amp. Range	125 Amp. Range
1	140	700	3370
2	100	500	2380
5	63	315	1510
10	45	222	1060
20	32	157	755
60	18	90	435

If starting currents exceed these values some precautions should be taken and the following suggestions are offered:

(*a*) Use a higher current range.

(*b*) Short circuit the current circuits with external switches.

(*c*) Use external current transformers of suitable ranges and short circuit their secondaries during starting.

The movable systems of the instruments which compose the Model 639 analyzer are so designed mechanically that they will withstand ordinary starting currents. The violent deflection of the ammeter movable system will result in no damage; but should it be desirable to avoid this, the movable system may be deflected its full amount by means of the starting current backstop until the starting period is ended.

Burden for External Transformers

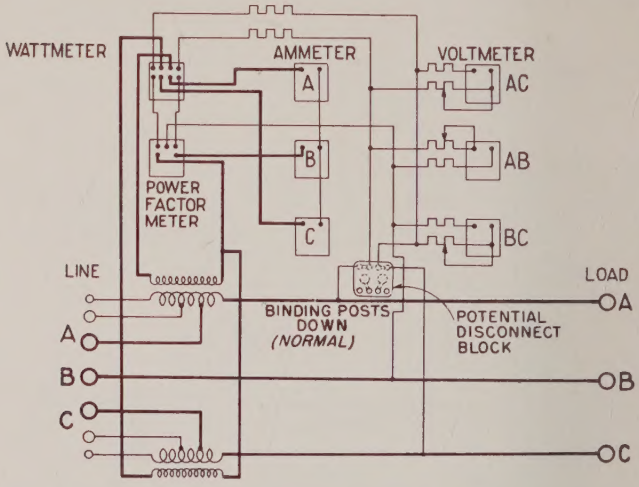
When using external transformers the analyzer would present the following burdens:

Potential circuit per phase, 7 volt amperes
Current circuit per phase, 6 volt amperes

It is recommended that the phase angle of the external current transformers be not greater than 50 minutes for this burden at full load.

DIAGRAM OF INTERNAL CONNECTIONS

SCHEMATIC DIAGRAM OF INTERNAL CONNECTIONS



Binding Posts

Model 639, Industrial Analyzer has bakelite covered nickel plated brass binding posts which are so designed and constructed as to withstand ordinary abuse without chipping.

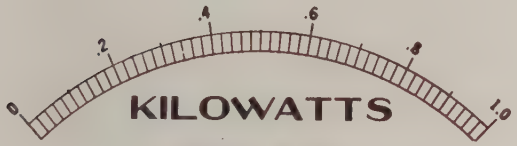
Potential Disconnect Block

Type 2 has this block mounted in the panel between the "voltage range" switch and the "voltage across phases" switch. The "normal" position for this block is with the binding posts down and out of the way. It can be mounted with the binding posts up and accessible which disconnects the voltmeter and the potential circuits of the wattmeter and power factor meter from the "A" and "C" line binding posts. This permits potential connections to be made to these instruments, by means of the binding posts on the potential disconnect block, which are isolated from the current circuits of the instruments for checking or special uses as outlined.

Insulation

The current transformers are insulated for 1000 volts. Measurements on circuits above this voltage require both current and potential transformers.

VOLTS
A.C.

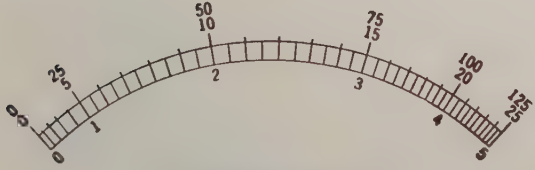


KILOWATTS

AMPS	5	25	125
VOLTS	SCALE MULTIPLIER		
150	1	5	25
300	2	10	50
600	4	20	100

POWER FACTOR
3 PHASE

LAG **LEAD**



AMPERES
A.C.

DIMENSIONS ..... 18⅞"x10⅞"x6⅞"
APPROXIMATE WEIGHT ..... 32 lbs.
ACTUAL SCALE LENGTH ..... 3½"

Suggestions for Connecting Analyzer to Circuits

All cables used for connections to source or load should be of sufficient size to carry the currents involved and connected securely to the binding posts and the circuit terminals.

For currents up to 125 amperes use No. 2 cable
" " " " 25 " " " 12 "
" " " " 5 " " " 16 "

For further data pertaining to cables see table on page 24.

A most convenient method is to make connections at the fuse blocks by using dummy fuses with cables attached. Illustrations of this are shown on page 9. The cables connecting to these dummy fuses may be connected to the analyzer. When convenient to interrupt service, it is only necessary to remove the good fuses from the cutout and insert the dummy fuses with cables attached. This may be done very quickly. This method is only a suggestion and may not always be practical.

When using the above method be certain that the circuit is protected by other fuses or circuit breakers as these dummy fuses remove the protection at that point.

The selection of the proper current range or the proper external transformer may be accomplished by the use of the tables to be found at the end of this book; for example, suppose we have a 10 horse power 110 volt single phase motor to test. From the table on page 25 the current at full load should be 86 amperes and we may therefore use the 125 ampere range of the analyzer.

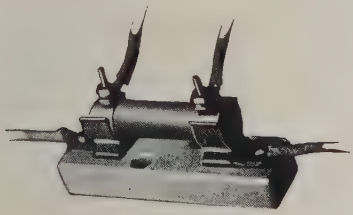
If we should wish to test a 100 horse power, 220 volt 3 phase induction motor, from the table on page 25, we find the current 250 amperes.

Weston Model 461 transformers or their equivalent, are necessary with two turns of cable wound through the hole for 400/5, or with 4 turns for 200/5 if motor is not fully loaded. The table on page 24 shows that for rubber insulation we would need a cable having an area of 167,800 circular mils. Connect according to diagram B, page 15. If the tables do not show the current required for a particular size motor, it may be calculated from data on page 26.

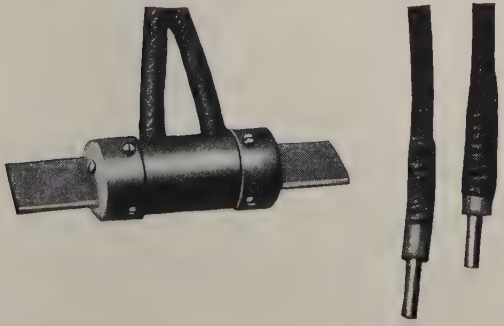
Take the following example: 100 horse power, 220 volt, 3 phase induction motor at 900 R.P.M. and ¾ load. Table on page 28 shows 100 H. P. motor for 900 R.P.M. at ¾ load has power factor of 87%. Table on page 29 shows 100 H. P. motor for 900 R.P.M. at ¾ load has efficiency of 91%.

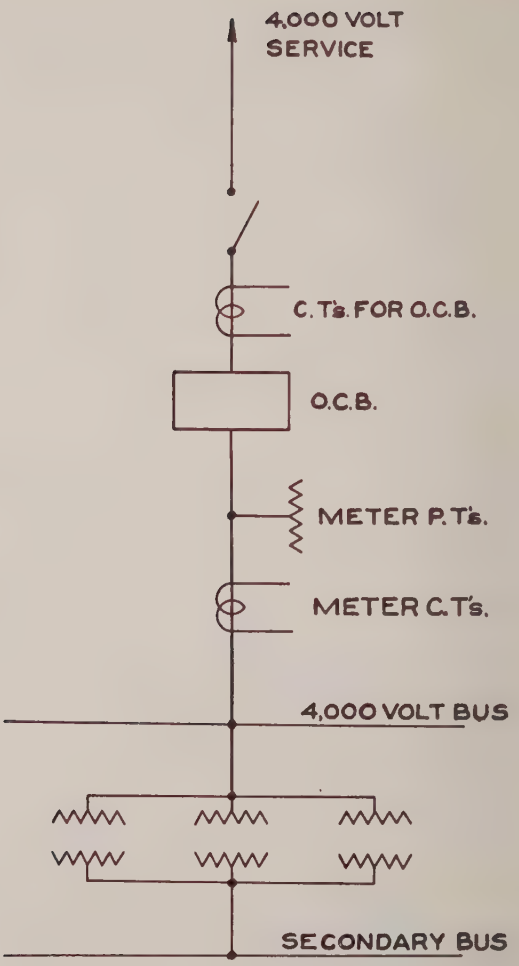
$$\text{Amperes} = \frac{\text{H.P.} \times 746}{1.73 \times \text{E} \times \text{Eff.} \times \text{P.F.}} = \frac{100 \times 746}{1.73 \times 220 \times .91 \times .87} = 248$$

Various types of cut-out fuses for measuring current without interrupting service



"Dummy" cartridge fuse in use





One Line Diagram of typical Service Connection.

The Analyzer may be connected to the meter current and potential transformers. If this is either impossible or undesirable the Analyzer should be connected at the secondary bus or at the individual load connections. In all cases be certain that suitable protection is provided for the Analyzer.

DIAGRAMS OF TEST CONNECTIONS

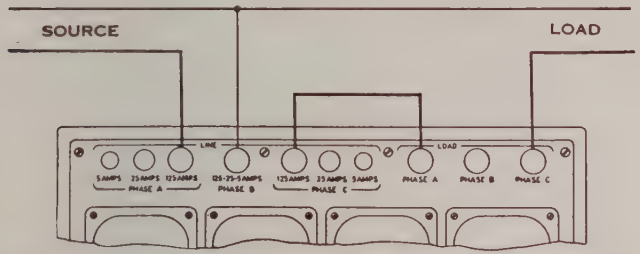
Single Phase Loads

The diagrams of connections as shown on pages 11, 12 and 13 may be used for all two wire circuits.

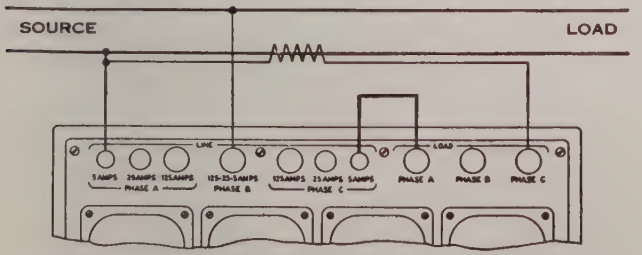
It will be observed that a connection is made on the analyzer from the "C" to the "A" phase, by means of which both elements of the wattmeter are used. This is shown so as to get as great a deflection of the wattmeter movement as possible. This is not essential as the wattmeter readings are correct regardless of whether one or both elements are used. If only one element of the wattmeter is used, the divisor of two should be omitted.

For single phase, three wire circuits, the connections as shown for three phase three wire, should be used.

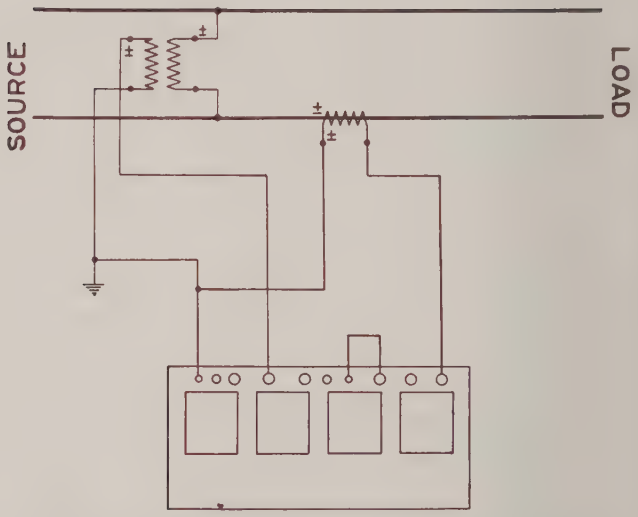
In all single phase measurements, the indications of the power factor meter should be disregarded.



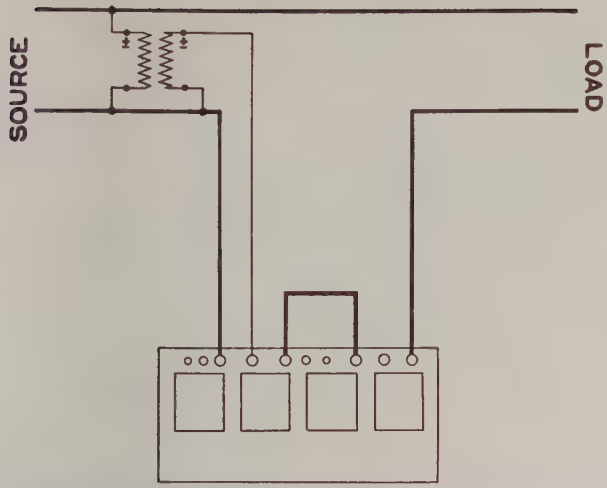
SINGLE PHASE, 2-WIRE CIRCUIT, both elements of wattmeter in series. Read voltage AB, current A, apply the wattmeter multiplier as found on the wattmeter scale and then divide by 2. Disregard the power factor indication.



SINGLE PHASE, 2-WIRE CIRCUIT using a single current transformer and with two current elements in series, read voltage AB and current A using 5 ampere scale and applying transformer multiplier. Divide kilowatt reading on 5 ampere and corresponding voltage scale by 2; then apply transformer multiplier. Disregard power factor indication.



SINGLE PHASE, 2-WIRE CIRCUIT using a current transformer and a potential transformer, the current elements of the analyzer in series, read voltage AB using 150 volt range and scale, multiply by potential transformer ratio, current A using 5 ampere scale and applying current transformer ratio. Read Kilowatts on scale corresponding to 5 amperes and 150 volts then divide by 2 and multiply by current and potential transformer ratios.



SINGLE PHASE, 2-WIRE CIRCUIT using a potential transformer and direct connected for the current circuits with the current elements in series. Read voltage AB using 150 volt scale and range, multiply by transformer ratio Read Kilowatts on scale corresponding to 150 volts and current range selected, divide by 2 and multiply by the potential transformer ratio. Read current A using scale corresponding to range selected.

2 Phase Loads

When using the analyzer on 2 phase loads, the readings of the power factor meter, and those of the ammeter when connected for the "B" wire, should be disregarded.

See page 4 for transformer burden data.

2 Phase 3 Wire Loads

Connections are to be made to the analyzer in the same manner as for the 3 phase, 3 wire loads.

2 Phase 4 Wire Loads

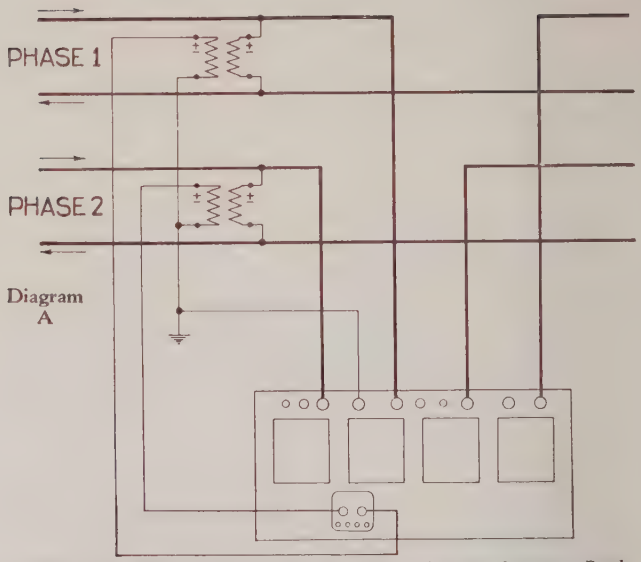
The phases of a 2 phase 4 wire system or load are insulated from each other and this characteristic must not be altered when measurements are to be made.

The Model 639 Type 2 Analyzer is provided with a potential disconnect block which mounts in the panel between the "voltage across phases" and "voltage range" switch. This block serves to disconnect the voltmeter and the potential circuits of the wattmeter and power factor meter from the primaries of the internal current transformers.

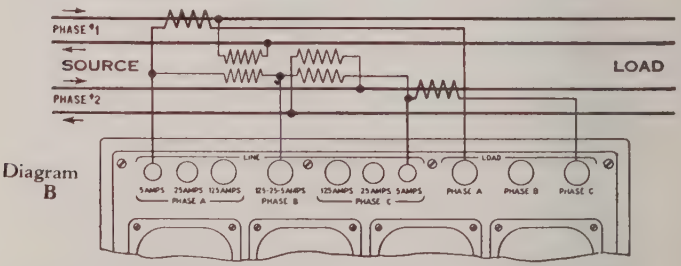
This feature is utilized as shown in diagram A on page 14.

When external current transformers are used with the potential transformers, the block should be in its "normal" position. See diagram B on page 14 for current transformer connections.

If it should be desirable or necessary to dispense with external transformers entirely, the phases may be treated independently as single phase circuits, the block, of course, being mounted in its "normal" position.



2 PHASE, 4-WIRE CIRCUIT with two potential transformers. Read voltage AB and AC using 150 volt range and apply the potential transformer ratio. Read current in phase A and C. Read wattmeter scale, apply multiplier as found on scale, then multiply by potential transformer ratio. Disregard the readings of the power factor meter, and the ammeter when on the "B" phase.



2-PHASE, 4-WIRE CIRCUIT using current and potential transformers. The use of both transformers is necessary to isolate the separate phases. Read voltage AB or AC applying potential transformer multiplier. Read current in phase A or phase C applying current transformer multiplier. Read wattmeter on 1 K.W. scale applying both current and potential transformer multipliers. Disregard power factor meter indication.

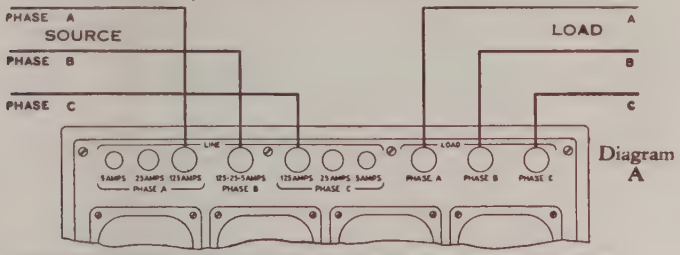
3 Phase 3 Wire Loads

The analyzer has been designed for use principally on 3 phase, 3 wire loads. Diagrams on pages 15 and 16 show the connections necessary for all 3 phase, 3 wire testing.

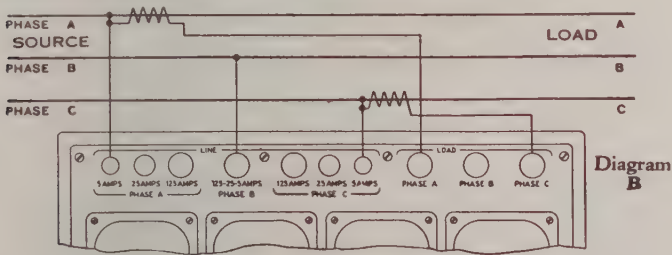
See page 4 for transformer burden data.

The readings of the wattmeter are correct regardless of unbalance or power factor of the load.

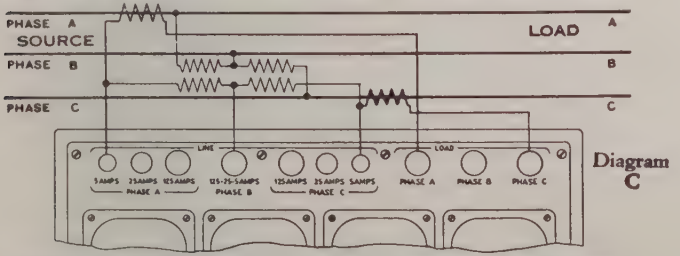
The readings of the power factor meter are correct for any current down to 1/5 of the full scale value.



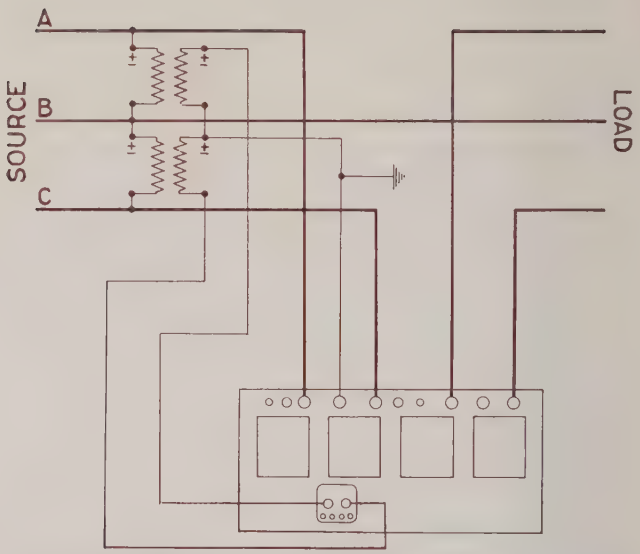
3-PHASE, 3-WIRE CIRCUIT direct. Read voltage across phases as desired as well as current in any phase. Apply multiplier as given on wattmeter scale to reading as necessary for voltage and current range used. Read power factor direct.



3-PHASE, 3-WIRE CIRCUIT with two current transformers. Read voltage across phases as desired and current in any wire, applying transformer multiplier to 5 ampere scale on ammeter. Apply transformer multiplier to wattmeter, also multiplying by multiplier of 1, 2 or 4, depending upon voltage range as indicated on wattmeter scale. Read power factor direct.



3-PHASE, 3-WIRE CIRCUIT using both current and potential transformers. Read voltage across phases as desired applying potential transformer multiplier to 150 volt scale to which the voltage range switch should be set. Read ammeter in any phase applying current transformer multiplier to 5 ampere scale. Read polyphase wattmeter on 1 K.W. scale and apply both current and potential transformer multipliers. Read power factor direct.



3-PHASE, 3-WIRE CIRCUIT with two potential transformers. Read voltage across phase as desired, use 150 volt range and apply potential transformer ratio. Read ammeter in any phase direct for range selected Read wattmeter scale, use multiplying factor for current and potential ranges selected, then multiply by potential transformer ratio.

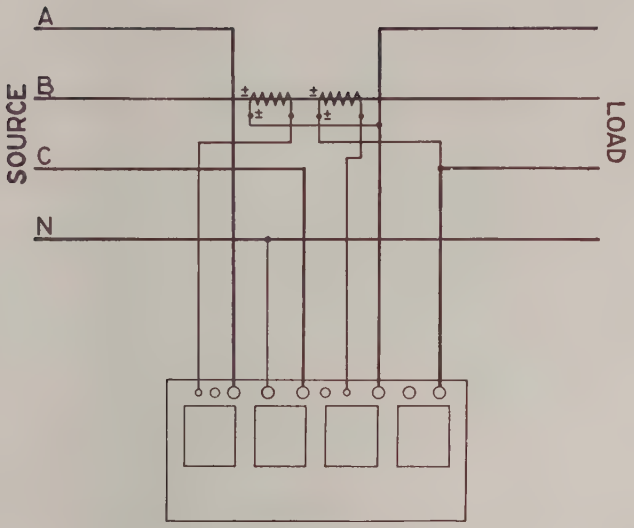
3 Phase 4 Wire Loads

As mentioned on page 1, the analyzer was designed primarily for three phase three wire loads therefore, when three phase four wire loads are to be analyzed certain limitations are to be expected.

1. The power factor meter has been designed for balanced three phase three wire loads. Its readings on three phase four wire loads should be disregarded.
2. The ammeter readings are not a measure of the line currents, except to a limited extent when the load is balanced, or that connections are made to the load as for three phase three wire.
3. The voltmeter readings will be "line to neutral" and "line to line" voltages depending upon position of voltage selector switch.
4. External current transformers must always be used.

If the three phase four wire load is balanced, no current in the neutral wire, it may be treated as outlined for a three phase three wire load and above limitations disregarded.

Regardless of the balance each phase may be treated as a single phase load and tested accordingly.



3-PHASE, 4-WIRE CIRCUIT. Two identical current transformers of suitable range having 5 ampere secondaries are connected in the "B" phase as shown.

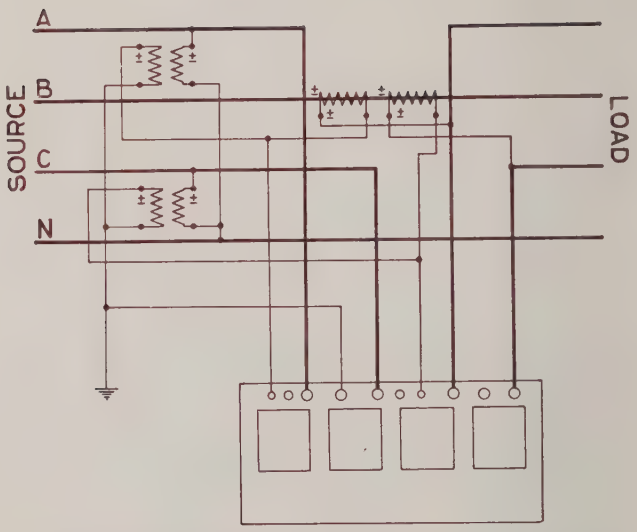
The external current transformers should have the same ranges as the transformers contained in the analyzer, that is 125/25/5 amperes.

The readings of the voltmeter, using proper range and scale, represent the following:

With switch at AB, the voltage from line A to neutral.
With switch at BC, the voltage from line C to neutral.
With switch at AC, the voltage from line A to line C.

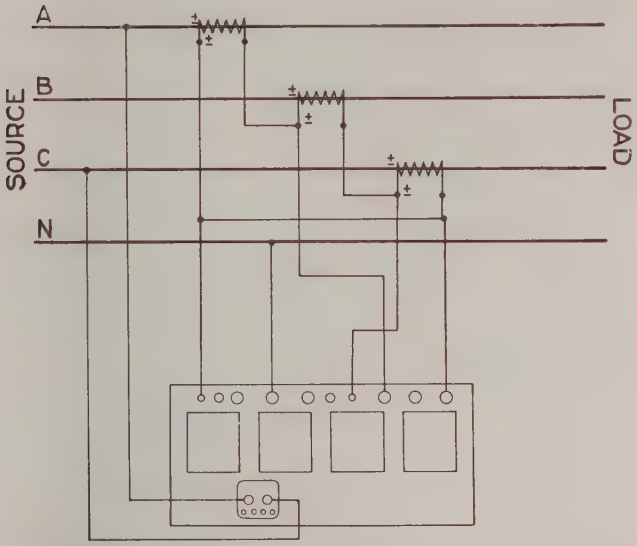
The wattmeter readings must be corrected by the multiplying factors found on the wattmeter scale.

When external potential transformers are used, as shown in following diagram, the readings of the voltmeter and wattmeter should be multiplied by the potential transformer ratio in addition to the above.



3-PHASE, 4-WIRE CIRCUIT. Two potential transformers having 115 volt secondaries, connected from neutral to lines "A" and "C". Two current transformers of suitable range having 5 ampere secondaries.

When currents to be measured are beyond the range of the internal current transformers the following connections should be used.



3-PHASE, 4-WIRE CIRCUIT. Potential direct connected. Three current transformers of suitable range having 5 ampere secondaries delta connected.

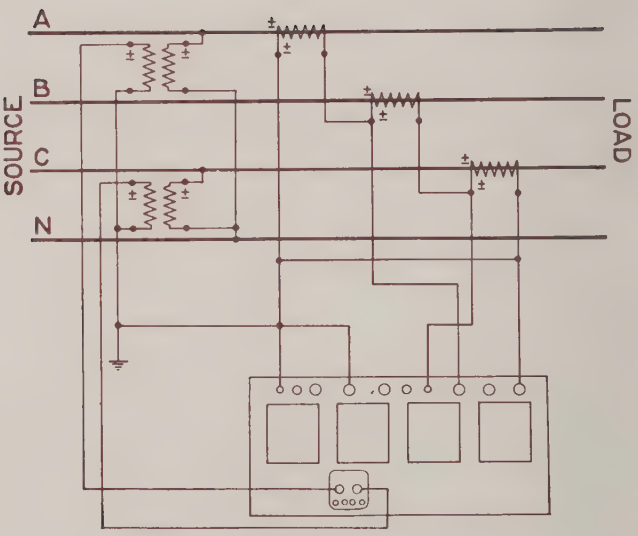
The readings of the voltmeter, using proper range and scale, represents the following:

With switch at AB, the voltage from line A to neutral.
With switch at BC, the voltage from line C to neutral.
With switch at AC, the voltage from line A to line C.

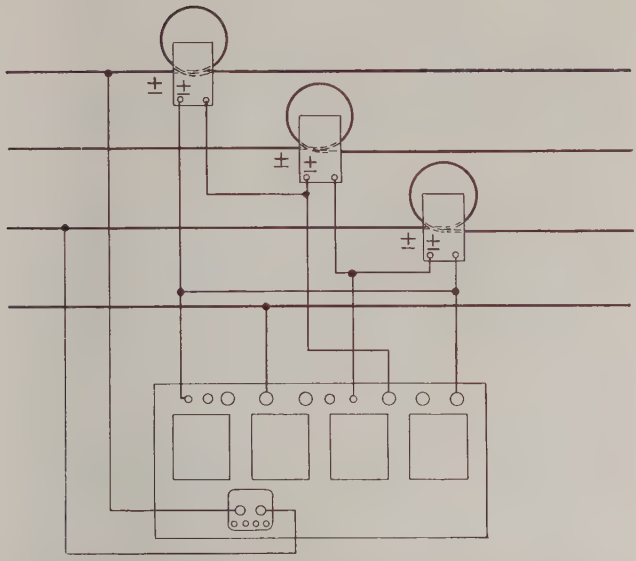
The wattmeter readings must be corrected by the multiplying factors found on the wattmeter scale and the external current transformer ratios.

Potential connections from lines A and C are connected to the disconnect block binding posts, with the block mounted with the binding posts up.

When external potential transformers are used, as shown in following diagram, the readings of the voltmeter and wattmeter should be multiplied by the potential transformer ratio in addition to the above.

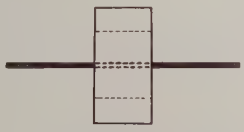


3-PHASE, 4-WIRE CIRCUIT. Two potential transformers of suitable range having 115 volt secondaries connected from neutral to lines "A" and "C". Three current transformers of suitable range having 5 amperes secondaries connected in delta.

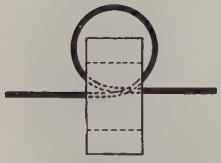


Above is the diagram of connections, as described on page 19, showing the method of inserting turns in transformer primaries.

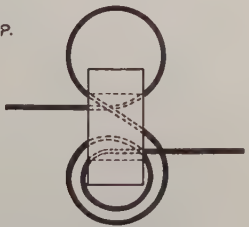
The sketches below show the arrangement of 1, 2 or 4 conductors to obtain current ranges when using Weston Model 461 current transformers.



1 CONDUCTOR
800 AMP. TO 5 AMP.



2 CONDUCTORS
400 AMP. TO 5 AMP.



4 CONDUCTORS
200 AMP TO 5 AMP.

DATA FOR CHECKING INSTRUMENTS

To Check Voltmeter

Turn the left hand switch (voltage selector), to AB. Then connect a-c source and standard to Line A-B binding posts. Turn the center switch to the desired range.

To Check Ammeter with Transformers

To check ammeter and transformer in phase A, set the right-hand switch (current selector) to "A". Connect a-c source and standard ammeter in series to binding posts "Line A" and "Load A".

To check ammeter and transformer in phase C, repeat using "C" position of switch and binding posts "Line C" and "Load C".

To Check Wattmeter

Each element of the wattmeter can be checked individually or both can be checked together by using a single phase wattmeter as a standard.

Mount disconnect block with the binding posts up. Use alternating current only.

To check element in phase A, connect current coil of standard wattmeter in series with "Line A" and "Load A" binding posts and a suitable load. Connect line potential to standard wattmeter potential circuit and to "B" binding post and left hand binding post on disconnect block.

To check element in phase C, repeat above using "Line C" and "Load C" binding posts in series with the standard wattmeter current circuit and load and "B" binding post and right hand binding post on disconnect block across the line.

To check both elements together, connect all current circuits in series with a load. This is done by connecting "Line C" binding post to "Load A" binding post. Then connect standard wattmeter current circuit and load in series with "Line A" and "Load C" binding posts. See first diagram on Page 11 for series connection of analyzer. Connect all potential circuits in parallel across the line. This is done by connecting one potential post of the standard wattmeters and "B" binding post to one side of the line and the other potential post of the standard wattmeter and each of the binding posts of the disconnect block to the other side of the line. Note that the wattmeter in the analyzer will indicate twice the watts indicated by the standard wattmeter.

To Check Power Factor Meter

After the voltmeter, ammeter and wattmeter have been checked, or are known to be correct, mount disconnect block with binding posts down. With a 3 phase, 3 wire balanced non-inductive load check the center mark on the power factor meter. Other marks on scale may be checked with computed value from volts, amperes and watts.

Transformers

In order to check the transformers, it is necessary to remove the analyzer from its case. The ammeter should be checked first and then used as the standard in the secondary circuit. Since the rated secondary current is one ampere, connect a one ampere standard in series with the ammeter at any convenient place. See internal connection diagram on Page 5. **Do Not open secondary circuit of transformer when primary circuit is energized.** Apply an alternating current to the primary of one of the transformers (set right-hand switch to "A" or "C" depending upon transformer used) and check ammeter against the standard. After the ammeter has been checked, remove standard ammeter and reconnect circuit where ammeter was inserted. Transformers can then be checked as specified under "To Check Ammeter With Transformers" on Page 22.

High Potential Test

In order to safeguard the operator, each Model 639 Analyzer is factory-tested with 1500 volts A.C. between the electrical circuit and all exposed metal parts.

ALLOWABLE CARRYING CAPACITIES OF COPPER WIRES

Single Conductor In Free Air

B. & S. Gauge	Area in Circular Mils	Amperes*
14	4,107	20
12	6,530	25
10	10,380	40
8	16,510	55
6	26,250	80
4	41,740	105
3	52,630	120
2	66,370	140
1	83,690	165
0	105,500	195
00	133,100	225
000	167,800	260
0000	211,600	300
.....	250,000	340
.....	300,000	375
.....	350,000	420
.....	400,000	455
.....	500,000	515
.....	600,000	575
.....	700,000	630
.....	800,000	680
.....	900,000	730
.....	1,000,000	780

The above table does not take into consideration the "volts lost" or "drop of potential," but covers heating only, based on room temperature of 30°C (86°F).

Insulated aluminum conductors will carry 84% of the current carried by copper wire without undue heating.

*Current for following insulation: Rubber type R, RW and RU (14-6); Thermoplastic type T and TW. For other insulations refer to latest edition of the National Electrical Code.

FULL LOAD CURRENT OF ALTERNATING CURRENT MOTORS

H.P. of Motor	Single-Phase Motors		Squirrel-Cage Induction Motors									
			Two-Phase					Three-Phase				
	110 V	220 V	110 V	220 V	440 V	550 V.	2200 V	110 V	220 V	440 V.	550 V.	2200 V
¼	2.4	.....	1.9	1.0	0.5	0.4	.....	2.2	1.1	0.6	0.5	.....
½	6.4	3.2	3.5	1.7	0.9	0.7	.....	4.0	2.0	1.0	0.8	.....
¾	9.0	4.5	4.8	2.4	1.2	1.0	.....	5.6	2.8	1.4	1.1	.....
1	11.8	5.9	6.0	3.0	1.6	1.2	.....	7.0	3.5	1.8	1.4	.....
1½	15.0	7.5	8.6	4.3	2.2	1.7	.....	10.0	5.0	2.5	2.0	.....
2	20.0	10.0	11.0	5.5	2.8	2.2	.....	12.8	6.4	3.2	2.6	.....
3	28.0	14.0	16.0	8.0	4.0	3.2	.....	18.4	9.2	4.6	3.7	.....
5	46.0	23.0	26.0	13.0	6.5	5.2	.....	30.0	15.0	7.5	6.0	.....
7½	68.0	34.0	38.0	19.0	9.5	7.6	.....	44.0	22.0	11.0	8.8	.....
10	86.0	43.0	48.0	24.0	12.0	9.6	.....	56.0	28.0	14.0	11.2	.....
15	.....	.....	70.0	35.0	17.0	14.0	3 6	80.0	40.0	20 0	16.0	4.1
20	.....	.....	90.0	45.0	23.0	18.0	4.6	104.0	52.0	26 0	21.0	5.4
25	.....	.....	112.0	56.0	28.0	22.0	5.7	130.0	65.0	28.0	26 0	6.7
30	.....	.....	132.0	66.0	33.0	26.0	6.8	152.0	76.0	33 0	31.0	7.8
40	.....	.....	174.0	87.0	43.0	35.0	9.0	200.0	100.0	50.0	40.0	10.3
50	.....	.....	216.0	108.0	54.0	43.0	11.1	250.0	125.0	63.0	50 0	12.9
60	.....	.....	260.0	130.0	65.0	52.0	13.4	300.0	150.0	75 0	60.0	15.5
75	.....	.....	320.0	160.0	80.0	64.0	16.5	370.0	185.0	93.0	74.0	19.0
100	.....	.....	430.0	215.0	108.0	86.0	22.0	500.0	250.0	125.0	100.0	26.0
125	.....	.....	520.0	260.0	130.0	104.0	27.0	600.0	300.0	150 0	120.0	31 0
150	.....	.....	640.0	320.0	160.0	128.0	33.0	740.0	370 0	185.0	148.0	38.0
175	.....	.....	.....	360.0	180.0	145.0	37 0	.....	420 0	210 0	170.0	43.0
200	.....	.....	.....	415.0	210.0	165.0	43 0	.....	480.0	240 0	195 0	49.0
225	.....	.....	.....	460.0	230.0	185.0	47.0	.....	530.0	265.0	215.0	55.0
250	.....	.....	.....	520.0	260.0	205.0	53.0	.....	600 0	300 0	240.0	62.0
275	.....	.....	.....	570.0	285 0	225.0	59.0	.....	660.0	330.0	265.0	68.0
300	.....	.....	.....	620.0	310.0	245.0	64 0	.....	720.0	360.0	290 0	74.0
350	.....	.....	.....	.....	360 0	290 0	75 0	.....	.....	420.0	335 0	87.0
400	.....	.....	.....	.....	405.0	320.0	83 0	.....	.....	465 0	370 0	95.0
450	.....	.....	.....	.....	465.0	370 0	95 0	.....	.....	535 0	430 0	110.0
500	.....	.....	.....	.....	520.0	415.0	105.0	.....	.....	600 0	480 0	123.0
600	.....	.....	.....	.....	620.0	495.0	125.0	.....	.....	715 0	572.0	147.0
750	.....	.....	.....	.....	755.0	605.0	155.0	.....	.....	785 0	700.0	180.0
1000	.....	.....	.....	.....	1035.0	825.0	215.0	.....	.....	1150 0	960.0	245.0

ELECTRICAL FORMULAE FOR DETERMINING HORSE-POWER, K.V.A., KILOWATTS AND AMPERES

To Find	Alternating Current			
	Single-Phase	Two-Phase, Four-Wire	Three-Phase, Three-Wire	Three-Phase, Four-Wire
*Amperes when Kilowatts is Known	$\frac{\text{K.W.} \times 1000}{\text{E} \times \text{P.F.}}$	$\frac{\text{K.W.} \times 1000}{2 \times \text{E} \times \text{P.F.}}$	$\frac{\text{K.W.} \times 1000}{1.73 \times \text{E} \times \text{P.F.}}$	$\frac{\text{K.W.} \times 1000}{3 \times \text{e} \times \text{P.F.}}$
Amperes when K.V.A. is Known	$\frac{\text{K.V.A.} \times 1000}{\text{E}}$	$\frac{\text{K.V.A.} \times 1000}{2 \times \text{E}}$	$\frac{\text{K.V.A.} \times 1000}{1.73 \times \text{E}}$	$\frac{\text{K.V.A.} \times 1000}{3 \times \text{e}}$
Amperes when Horse-power is Known	$\frac{\text{H.P.} \times 746}{\text{E} \times \text{Eff.} \times \text{P.F.}}$	$\frac{\text{H.P.} \times 746}{2 \times \text{E} \times \text{Eff.} \times \text{P.F.}}$	$\frac{\text{H.P.} \times 746}{1.73 \times \text{E} \times \text{Eff.} \times \text{P.F.}}$	$\frac{\text{H.P.} \times 746}{3 \times \text{e} \times \text{Eff.} \times \text{P.F.}}$
Horse-power (Out-put)	$\frac{\text{I} \times \text{E} \times \text{Eff.} \times \text{P.F.}}{746}$	$\frac{\text{I} \times \text{E} \times 2 \times \text{Eff.} \times \text{P.F.}}{746}$	$\frac{\text{I} \times \text{E} \times 1.73 \times \text{Eff.} \times \text{P.F.}}{746}$	$\frac{\text{I} \times \text{e} \times 3 \times \text{Eff.} \times \text{P.F.}}{746}$
Kilowatts	$\frac{\text{I} \times \text{E} \times \text{P.F.}}{1000}$	$\frac{\text{I} \times \text{E} \times 2 \times \text{P.F.}}{1000}$	$\frac{\text{I} \times \text{E} \times 1.73 \times \text{P.F.}}{1000}$	$\frac{\text{I} \times \text{e} \times 3 \times \text{P.F.}}{1000}$
K.V.A.	$\frac{\text{I} \times \text{E}}{1000}$	$\frac{\text{I} \times \text{E} \times 2}{1000}$	$\frac{\text{I} \times \text{E} \times 1.73}{1000}$	$\frac{\text{I} \times \text{e} \times 3}{1000}$

I equals Amperes; Eff. equals per cent Efficiency; P F. equals Power Factor; K. W. equals Kilowatts; K.V.A. equals Kilovolt-Amperes; H.P. equals Horsepower; "E" equals Volts from line to line or Phase to Phase; e equals Volts from Phase to Neutral.

*For three-wire, two-phase circuits the current in the common conductor is 1.41 times that in either of the other two conductors.

EFFICIENCY AND POWER FACTOR
SINGLE PHASE REPULSION INDUCTION MOTORS
110-220 VOLTS, 60 CYCLES

H.P.	Speed, R.P.M.			Efficiency %				Power Factor %			
				Loads				Loads			
	Syn.	Full Load	No Load	1¼	1	¾	½	1¼	1	¾	½
½	1800	1730	1940	69	67	63	53	93	93	92	89
½	1200	1135	1330	65	65	60	52	81	80	78	72
¾	1800	1725	1925	66	64	58	48	87.5	87.5	86.5	84
¾	1200	1170	1350	....	63	60.05	50	....	78	73	67
1	1800	1710	1960	....	70	64	55	....	96	95	94
1	1200	1120	1230	67	66	61	51	82	80	78	71
1½	1800	1750	1950	75	73	68	63	97	97.5	97	94
2	1800	1730	1920	72	73	67	58	97	98	98	97
2	1200	1100	1220	69	69	65	60	89	90	88	80
3	1800	1700	1900	74	76	74	62	97	98	98	97
3	1200	1150	1290	75	74	70	61	94	95	95	94
5	1800	1700	1900	78	79	76	68	99	98	92	82
5	1200	1160	1270	80	79	77	70	97	98	98	97
7½	1800	1720	1820	80	81	79	74	96	99	99	95
7½	1200	1130	1400	77	78	74	68	89	90	86	81
10	1800	1710	1845	79	80	76	70	97	98	97	95
10	1200	1140	1250	80	81	79	72	95	96	95	90
15	1800	1720	1830	80	81	79	74	96	99	99	95

APPROXIMATE POWER FACTOR IN PERCENT FOR 60 CYCLE POLYPHASE INDUCTION MOTORS—SQUIRREL CAGE TYPE

STANDARD VOLTAGES

H.P	Syn. Speeds	Loads		
		½	¾	Full
2	1800	68	78	85
2	1200	58	71	78.5
3	1800	71	81	86
3	1200	67	78	83
5	1800	77	87	90
5	1200	72	80	85
7½	1800	78	84.5	88
7½	1200	68	77	84
10	1800	78	84	89
10	1200	74	84	88
15	1800	79	80	88.5
15	1200	77	86	88.5
15	900	72	81	85
20	1800	78	87	90
20	1200	76	85	89
20	900	72	82	86
25	1800	76	84	89
25	1200	74	86	89.5
25	900	72	81	86.5
30	1800	80	88.5	90.5
30	1200	75	84	88.5
30	900	74	84	87
40	1800	81	90	91
40	1200	82	88 5	91 5
40	900	74	83	87
40	720	76	85	88.4
50	1800	85 5	90.5	92
50	1200	81	87.5	90.5
50	900	75	83	87
50	720	73 5	83	88
50	600	72.5	82	86.5
60	1200	89	92	93
60	900	78	88	91
60	720	74	84	88
60	600	75	84	88
75	1200	82	89	91.5
75	900	77	86	90
75	720	73.5	83	88
75	600	72 5	82	86.5
100	1200	82	89	91.5
100	900	78	87	90.5
100	720	75	84	89
100	600	71	81	86
125	900	78	87	90 5
125	720	68 5	80	85
125	600	66	78	84
150	900	80	88	91
150	720	70	80	85
150	600	73	83	87
200	900	81	88	91
200	720	80 5	87.5	90 5
200	600	75	84	88
250	900	84	89	91
250	600	85	83	87
250	400	62 5	74 5	80 5
300	720	83	88.	91
300	450	68	78	84
350	514	71	81	85
350	450	65	77 5	83
400	600	74	83	88
400	400	67	78	83
400	360	68	78	82
500	720	85	90	92
500	450	72	81	86

APPROXIMATE EFFICIENCIES IN PERCENT FOR 60 CYCLE POLYPHASE INDUCTION MOTORS—SQUIRREL CAGE TYPE.

All Standard Voltages Below 2200

H.P	Syn. Speeds	Loads		
		½	¾	Full
2	1800	78	81.5	82.5
2	1200	83	84 5	85
3	1800	86	87	87
3	1200	83 5	85 5	86
5	1800	84 5	86 5	87
5	1200	85	87	87
7½	1800	84	86	86 5
7½	1200	85	86 5	87
10	1800	88	89	90
10	1200	85	87	87
15	1800	87	89	90
15	1200	86	87 5	89
15	900	87	89	89
20	1800	87	89 5	90
20	1200	87	89	89
20	900	86	88	88.5
25	1800	88	89	89
25	1200	88	89	89 5
25	900	87	88 5	89
30	1800	87	89	90
30	1200	88	89	90
30	900	89	90	90
40	1800	88	89	90
40	1200	87 5	90	90
40	900	89	90	90
40	720	88.5	89 5	89
50	1800	84	87	87 5
50	1200	88	90	90 5
50	900	88	90	90 5
50	720	89	90	90
50	600	89	90	90
60	1200	88 5	89 5	90
60	900	89	90 5	90 5
60	720	90	91	90 5
60	600	89	89 5	89
75	1200	88 5	90 5	91
75	900	89	91	91 5
75	720	89 5	90 5	91
75	600	89	90	90 5
100	1200	88.5	90 5	91.5
100	900	89.5	91	91.5
100	720	90	91	91.5
100	600	90	91	91
125	900	90	91 5	92
125	720	89	91	91.5
125	600	90	91 5	91.5
150	900	89.5	91	91 5
150	720	90	91 5	91 5
150	600	89 5	90 5	90 5
200	900	89	91 5	92
200	720	90.5	91 5	91 5
200	600	90	91 5	91.5
250	900	90 5	91 5	91.5
250	600	91	92	92
250	400	91 5	92	92
300	720	90 5	91	91.5
300	450	91	91 5	91.5
350	514	91	92	92
350	450	91	92	92
400	600	91.5	92 5	92.5
400	400	92	92 5	93
400	360	91	92	92
500	720	92	92.5	92.5
500	450	92.5	92 5	93

The above efficiencies are for a first-grade standard line of motors. The efficiences of "slip ring" 25 cycle and 2200 volt motors will be somewhat less than the values given above.

Size of Wire	Number of Wires in One Conduit								
	1	2	3	4	5	6	7	8	9
	Minimum Size of Conduit, Inches								
14	½	½	½	¾	¾	1	1	1	1
12	½	½	¾	¾	¾	1	1	1	1¼
10	½	¾	¾	1	1	1	1¼	1¼	1¼
8	½	¾	1	1	1	1¼	1¼	1¼	1¼
6	½	1	1¼	1¼	1½	1½	2	2	2
5	¾	1¼	1¼	1¼	1½	2	2	2	2
4	¾	1¼	1¼	1½	2	2	2	2	2½
3	¾	1¼	1¼	1½	2	2	2	2½	2½
2	¾	1¼	1½	1½	2	2	2½	2½	2½
1	¾	1½	1½	2	2	2½	2½	3	3
0	1	1½	2	2	2½	2½	3	3	3
00	1	2	2	2½	2½	3	3	3	3½
000	1	2	2	2½	3	3	3	3½	3½
0000	1¼	2	2½	2½	3	3	3½	3½	4
200000 CM	1¼	2	2½	2½	3	3	3½	3½	4
225000	1¼	2½	2½	3	3	3½	.....	.....	.....
250000	1¼	2½	2½	3	3	3½	.....	.....	.....
300000	1¼	2½	3	3	3½	3½	.....	.....	.....
350000	1¼	2½	3	3½	3½	4	.....	.....	.....
400000	1¼	3	3	3½	4	4	.....	.....	.....
450000	1½	3	3	3½	4	4½	.....	.....	.....
500000	1½	3	3	3½	4	4½	.....	.....	.....
550000	1½	3	3½	4	4½	5	.....	.....	.....
600000	2	3	3½	4	4½	5	.....	.....	.....
650000	2	3½	3½	4	.....	.....	.....	.....	.....
700000	2	3½	3½	4½	.....	.....	.....	.....	.....
750000	2	3½	3½	4½	.....	.....	.....	.....	.....
800000	2	3½	4	4½	.....	.....	.....	.....	.....
850000	2	3½	4	4½	.....	.....	.....	.....	.....
900000	2	3½	4	4½	.....	.....	.....	.....	.....
950000	2	4	4	5	.....	.....	.....	.....	.....
1000000	2	4	4	5	.....	.....	.....	.....	.....
1100000	2½	4	4½	6	.....	.....	.....	.....	.....
1200000	2½	4½	4½	6	.....	.....	.....	.....	.....
1250000	2½	4½	4½	6	.....	.....	.....	.....	.....
1300000	2½	4½	5	6	.....	.....	.....	.....	.....
1400000	2½	4½	5	6	.....	.....	.....	.....	.....
1500000	2½	4½	5	6	.....	.....	.....	.....	.....
1600000	2½	5	5	6	.....	.....	.....	.....	.....
1700000	3	5	5	6	.....	.....	.....	.....	.....
1750000	3	5	5	6	.....	.....	.....	.....	.....
1800000	3	5	6	6	.....	.....	.....	.....	.....
1900000	3	5	6	.....	.....	.....	.....	.....	.....
2000000	3	5	6	.....	.....	.....	.....	.....	.....

Where single conductor, single braid, solid wires only are used, four No. 14 wires may be installed in a ½-inch conduit and up to seven No. 14 wires in a ¾-inch conduit. Three No. 12 wires may be installed in a ½-inch conduit, four No. 10 wires in a ¾-inch conduit and three No. 8 wires in a ¾-inch conduit.

APPROXIMATE AMPERES PER TERMINAL AND FUSE DATA FOR *THREE PHASE INDUCTION MOTORS

H.P.	Full Load Amperes at				Starting Fuse Amperes at				Running Fuse Amperes at			
	110 Volts	220 Volts	440 Volts	550 Volts	110 Volts	220 Volts	440 Volts	550 Volts	110 Volts	220 Volts	440 Volts	550 Volts
1	6 0	3 0	1 5	1.2	20	10	5	5	10	5	5	5
2	12 0	6 0	3 0	2 4	30	20	15	10	15	10	5	5
3	16.0	8 0	4 0	3 2	50	30	20	10	20	15	5	5
5	28 0	14 0	7 0	5 6	70	40	25	15	35	20	10	10
7½	40 0	20 0	10 0	8 0	90	60	30	25	55	25	15	10
10	54 0	27 0	13 5	10 7	120	70	40	30	70	35	20	15
15	74 0	37 0	18 5	14.8	165	85	50	40	100	50	25	20
20	.....	50 0	25 0	20 0	.....	110	65	55	..	80	35	30
25	.....	62 0	31 0	25 0	.....	140	70	65	....	85	40	35
30	.....	74 0	37 0	29 6	.....	160	80	70	.....	100	50	40
35	.....	86 0	43 0	34.2	.....	185	95	75	.....	125	60	45
40	....	98.0	49 0	39 2	....	190	110	85	....	130	65	55
50	.....	124 0	62 0	49 5	....	195	130	110	...	165	80	65

***For two phase motors multiply the amperes per terminal by .866. For single phase multiply by 1.732.**

The above table covers current for motors operating at full load only. For motors operating at less loads the current will not be directly in proportion owing to the lower power factor and decreased efficiency at loads less than normal.

For example a 20-H.P. 550 Volt motor will take 20 amperes at full load, 16 amperes at three-quarter load and 12 amperes at one half load.

STARRETT LABORATORIES

POLYPHASE INDUCTION MOTORS

H.P.	Poles	Synchronous Speed		Approximate Full Load Speed		Starting Current for Full Load Torque	Starting Torque at Rated Voltage	Pull Out Torque
		25 Cycles	60 Cycles	25 Cycles	60 Cycles			
1	4	750	1800	690	1700	2.7 to 3	1.3	2.3
2	4	750	1800	690	1700	2.7 to 3	1.3	2.3
2	6	500	1200	460	1120	2.7 to 3	1.3	2.3
3	4	750	1800	690	1700	2.7 to 3	1.3	2.3
3	6	500	1200	460	1120	2.7 to 3	1.3	2.3
5	4	750	1800	690	1700	2.7 to 3	1.5	2.5
5	6	500	1200	460	1120	2.7 to 3	1.3	2.5
7½	4	750	1800	700	1720	2.7 to 3	2	3
7½	6	500	1200	465	1135	2.7 to 3	1.5	2.5
10	6	500	1200	465	1135	2.7 to 3	1.5	2.5
10	8	375	900	349	850	2.7 to 3	1.5	2.5
15	6	500	1200	470	1135	2.7 to 3	1.5	2.5
15	10	300	720	282	680	2.7 to 3	1.5	2.5
20	6	500	1200	470	1135	2.7 to 3	1.5	2.5
20	8	375	900	353	850	2.7 to 3	1.5	2.5
25	6	500	1200	470	1135	2.7 to 3	1.5	2.5
25	12	250	600	237	565	2.7 to 3	1.5	2.5
30	8	375	900	355	850	2.7 to 3	1.5	2.5
40	8	375	900	360	850	2.7 to 3	1.5	2.5
50	8	375	900	360	850	2.7 to 3	1.75	2.75
75	10	300	720	288	680	3.3 to 5	1.75	2.75
100	10	300	720	288	690	3.3 to 5	1.75	3
150	12	.....	600	.....	575	3.3 to 5	1.75	3
200	12	.....	600	.....	575	3.5	1.5	2.5

Note: This table covers average motors. Column entitled "starting current for full load torque" shows the number of times that the full load current must be multiplied in order to obtain the starting current when motor is called upon to deliver its full load torque at starting.

Column entitled "starting torque at rated voltage" shows the torque exerted by the motor in proportion to the full load torque when the rated voltage of the motor is applied

CONTINUOUS RATED SYNCHRONOUS MOTORS FOR BELT DRIVING
0.8 POWER FACTOR, 2-3 PHASE 60 CYCLE STANDARD VOLTAGES

Capacity						Efficiency in %						
						H.P.—1.0 P-F			H.P —0.8 PF			K.W. Loss as Synchronous Condenser
Input Kv.-a 0.8 P.F.	Output H.P	Input K.W 1.0 P F.	Output H.P	Synchronous Condenser Kv.-a	Speed R.P.M	Full Load	¾ Load	½ Load	Full Load	¾ Load	½ Load	
37.5	35	34	40	30	1200	88.5	86.5	83.5	85.2	83.4	78.8	5
56.3	55	50	60	45	1200	89.5	88	84 5	87	84	79.5	6
75	70	65	80	60	1200	91	89 5	86.5	88.3	84	81.6	7½
112.5	110	95	120	90	1200	92.2	90.6	87 5	90.1	86.8	85.7	9½
112.5	110	95	120	90	900	92.1	90.5	87	90.1	88.9	85.2	10
150	145	130	160	120	900	92.2	91	88	91	89	85.9	12
150	145	130	160	120	720	92.2	91	88	89.5	88	84.3	13
150	145	130	160	120	600	92.2	91	88	89.5	88	84 3	13
225	220	190	240	180	900	93.1	92	89 1	91.7	90 5	87 2	16
225	220	190	240	180	720	93	91.9	88.9	91 6	90 5	86 8	16
225	220	190	240	180	600	93	91.9	88.9	91 6	90.5	86.9	16
300	300	255	320	240	720	93.7	92.5	89.3	92.2	91	87 7	20
300	300	255	320	240	600	93.7	92.5	89.3	92.4	91.2	87.8	20

The figures given in the last column shows the K.W. required to drive the motor as a synchronous condenser for power factor correction.

SIZE OF WIRE (B. & S. GAUGE) REQUIRED FOR SINGLE PHASE (1) *TWO PHASE (2) AND THREE PHASE (3) MOTORS

H.P.	Rubber Insulation												Other Insulation											
	110 Volts			220 Volts			440 Volts			550 Volts			110 Volts			220 Volts			440 Volts			550 Volts		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
½	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
1	8	14	14	12	14	14	14	14	14	14	14	14	8	14	14	12	14	14	14	14	14	14	14	14
2	6	10	10	8	14	12	12	14	14	14	14	14	6	10	10	8	14	12	12	14	14	14	14	14
3	4	8	8	8	12	10	10	14	14	12	14	14	4	8	8	8	12	10	8	14	14	12	14	14
5	2	6	6	6	8	8	8	10	12	10	14	14	2	6	6	6	8	8	8	12	12	10	14	14
7½	0	4	4	4	8	6	6	8	10	8	12	12	0	4	4	4	8	6	6	10	10	8	12	12
10	....	2	2	....	6	6	....	8	8	....	10	10	....	2	2	....	6	6	....	8	8	....	10	10
15	....	1	0	....	4	4	....	6	8	....	8	8	....	1	0	....	4	4	....	8	8	....	8	8
20	....	....	....	....	2	2	....	6	6	....	8	6	....	....	....	....	2	2	....	6	6	....	8	6
25	....	....	....	....	2	1	....	4	6	....	6	6	....	....	....	....	2	1	....	6	6	....	6	6
30	....	....	....	....	1	0	....	4	4	....	6	6	....	....	....	....	1	0	....	4	4	....	6	6
35	....	....	....	....	0	0	....	4	2	....	6	4	....	....	....	....	0	0	....	4	2	....	6	4
40	....	....	....	....	0	00	....	2	2	....	6	4	....	....	....	....	0	0	....	4	2	....	6	4
50	....	....	....	....	00	000	....	1	1	....	4	2	....	....	....	....	0	0	....	2	1	....	4	2

* Two Phase Sizes for Four Wire Systems.

STABRO LABORATORIES

SYNCHRONOUS SPEEDS—ALTERNATING CURRENT GENERATORS AND MOTORS

Number of Poles	Revolutions Per Minute When Frequency is				
	25 Cycles	30 Cycles	40 Cycles	50 Cycles	60 Cycles
2	1,500	1,800	2,400	3,000	3,600
4	750	900	1,200	1,500	1,800
6	500	600	800	1,000	1,200
8	375	450	600	750	900
10	300	360	480	600	720
12	250	300	400	500	600
14	214	257	343	428	514
16	188	225	300	375	450
18	167	200	267	333	400
20	150	180	240	300	360
22	136	164	217	273	327
24	125	150	200	250	300
26	115	138	185	231	280
28	107	128	171	214	257
30	100	120	160	200	240
32	94	113	150	188	225
36	83	100	133	166	200
44	79	82	109	136	164
48	63	75	100	125	150
54	56	66	90	111	133
60	50	60	80	100	120
68	44	53	71	88	106
72	42	50	67	83	100
96	31	38	50	64	75
100	30	36	48	60	72

STANDARDIZED STRANDING

Strands		Cable		Allowable Carrying Capacities, Amperes		
No. of Strands Mils. Dia.	B. & S. Gauge No.	Area in Cir. Mils.	Outside Dia. Over Copper	Table A Rubber Insulation	Table B Varnished Cloth Insulation	Table C Other Insulation
7/ 25	22	4,490	.075	15	18	20
7/ 32	20	7,150	.096	20	25	25
7/ 40	18	11,370	.120	25	30	35
7/ 51	16	18,080	.153	35	40	50
7/ 64	14	28,740	.192	50	60	70
7/ 81	12	45,710	.253	70	85	90
7/ 91	11	58,000	.273	80	95	110
7/102	10	72,680	.306	90	10	130
19/ 64	14	78,030	.320	100	120	150
19/ 72	13	98,380	360	125	150	175
19/ 81	12	124,900	.405	150	180	210
19/ 91	11	157,300	.455	175	210	250
19/107	*	217,500	.540	225	270	325
19/114	9	248,700	.570	250	300	350
37/ 91	11	306,400	637	275	330	400
37/ 97	*	347,500	.679	300	360	450
37/102	10	381,200	.714	325	390	500
37/116	*	484,300	.798	400	480	600
61/102	10	633,300	918	475	565	700
61/107	*	698,000	.963	500	600	750
61/114	9	798,300	1.030	550	660	825
61/121	*	893,100	1.090	600	720	900
61/128	8	1,007,000	1.150	650	780	1000
91/114	9	1,191,000	1.250	725	870	1125
91/128	8	1,502,000	1.410	850	1020	1350
127/114	9	1,660,000	1.480	900	1100	1460
127/128	8	2,097,000	1.660	1100	1300	1700

*These individual strands are odd sizes not listed in the American or B. & S. Tables.

MP MASTER
MA30814